CHAPTER 5

SHEAR

5-1. Shear Strength

The shear strength V_c provided by concrete shall be computed in accordance
with ACI 318 except in the cases described in paragraphs 5-2 and 5-3.

5-2. Shear Strength for Special Straight Members

The provisions of this paragraph shall apply only to straight members of box
culvert sections or similar structures that satisfy the requirements of 5-2.a
and 5-2.b. The stiffening effects of wide supports and haunches shall be
included in determining moments, shears, and member properties. The ultimate
shear strength of the member is considered to be the load capacity that causes
formation of the first inclined crack.

     a. Members that are subjected to uniformly (or approximately uniformly)
distributed loads that result in internal shear, flexure, and axial
compression (but not axial tension).

     b. Members having all of the following properties and construction
details.

     (1) Rectangular cross-sectional shapes.

     (2) ℓ_n/d between 1.25 and 9, where ℓ_n is the clear span.

     (3) f_c' not more than 6,000 psi.

     (4) Rigid, continuous joints or corner connections.

     (5) Straight, full-length reinforcement. Flexural reinforcement shall
not be terminated even though it is no longer a theoretical requirement.

     (6) Extension of the exterior face reinforcement around corners such
that a vertical lap splice occurs in a region of compression stress.

     (7) Extension of the interior face reinforcement into and through the
supports.

     c. The shear strength provided the concrete shall be computed as

$$V_c = \left[\left(11.5 - \frac{\ell_n}{d} \right) \sqrt{f_c'} \sqrt{1 + \frac{N_u/A_g}{5\sqrt{f_c'}}} \right] bd \qquad (5\text{-}1)$$

at a distance of $0.15\ell_n$ from the face of the support.

    d. The shear strength provided by the concrete shall not be taken greater than

$$V_c = 2\left[12 - \left(\frac{\ell_n}{d}\right)\right]\sqrt{f_c'}\ bd \qquad (5-2)$$

and shall not exceed $10\sqrt{f_c'}\ bd$.

5-3. Shear Strength for Curved Members

At points of maximum shear, for uniformly loaded curved cast-in-place members with R/d > 2.25 where R is the radius curvature to the centerline of the member:

$$V_c = \left[4\sqrt{f_c'}\ \sqrt{1 + \frac{N_u/A_g}{4\sqrt{f_c'}}}\ \right]bd \qquad (5-3)$$

The shear strength shall not exceed $10\sqrt{f_c'}\ bd$.

5-4. Empirical Approach

Shear strength based on the results of detailed laboratory or field tests conducted in consultation with and approved by CECW-ED shall be considered a valid extension of the provisions in paragraphs 5-2 and 5-3.